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Perspectives on Serials in the Hybrid Environment

HARRIET LIGHTMAN
and
JOHN P. BLOSSER
Editors

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& Technical Services

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3 Science and Engineering Serials: Issues and Challenges in the Electronic Environment

ROBERT C. MICHAELSON, ANNA WU REN, AND DANA L. ROTH

Science and engineering journals have long presaged trends in scholarly communication as a whole. Together with medical journals, these journals have always been the most expensive titles as well as those that increased most rapidly in price. Thus they were at the forefront of a shift in library purchasing away from monographs toward collections that are heavily comprised of serials. Science and engineering journals were also among the first to adopt online versions and to provide links to citations and other enhancements, such as rotatable images and multimedia. In additon, the science, technology, and medicine (STM) community was the first to introduce early open access (OA) models, such as arXiv.

Pricing Issues: The Core Problem

Based on past trends among all scholarly journals, including STM journals, the most important consideration concerns price. However, the business model used by many commercial STM publishers, in which researchers provide articles and refereeing services to publishers for free, who in turn sell them back to the researchers' institutions at a substantial premium, is quickly becoming unsustainable as a result of the following factors:

Over a ten-year period, subscription prices have increased an average of 7 percent per annum, resulting in a doubling of prices.

Often European-based STM publishers have not adjusted prices in accordance with fluctuating foreign exchange rates but rather have

taken advantage of currency fluctuations, which has been especially harmful for dollar-based customers.

Many established journals, particularly those that are part of large package purchases, have chronically low ISI impact factors. There are significant differences in cost-effectiveness (where cost-effectiveness is the inverse of Barschall's measure of cost per 1000 characters/impact factor when compared with nonprofit and society journals).[1] Some long-established publications with low-impact factors publish so many articles that canceling them is difficult—a problem exacerbated by packages of journals with limitations on cancellation—despite their poor cost-effectiveness.

Increased dependence on big deals, in which libraries acquire electronic access to a publisher's entire list for a price based on a combination of factors. Some big deals preclude cancellations, forcing libraries to retain every title offered, including those with low-impact factors or those that might be peripheral or marginal to the library's mission.

Academically sound, inexpensive OA titles published by nonprofit organizations and scholarly societies are offered as an alternative to high-priced commercial publications.

As a result, a serious disconnect exists between the cost per article, cost per page, and cost-effectiveness of commercially published journals versus those published by learned societies. Although individual STM journals enjoy a quasi-monopoly, studies of journals in specific subjects or with specific content make it possible to compare costs.

Subscription Price Increases

Academic libraries have a long history of acceding to faculty requests when specific journal titles are desired. However, this approach to serials collection management is rapidly becoming untenable. Collection development policies should reflect more quantitative selection measures, namely quality, price and availability, and usage. While many faculty members are either unaware or unconcerned about the pricing of their favorite journals, an important aspect of a librarian's responsibilities is making the academic community aware of price increases. One mechanism to raise awareness is to compare costs for related titles and present users with the raw data in a number of ways.

Simple subscription cost comparisons quickly put the problem into perspective (table 1). Combining this data with pagination comparisons sharpens this perspective and gives faculty members solid data for decision making (tables 2 and 3).

TABLE 1
Cost Comparisons for Related Titles

	SUBSCRIPTION COST						
JOURNAL	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	TOTAL ($)
Inorganic Chemistry	1,782	1,889	2,021	2,208	2,418	2,604	$12,922
Dalton Transactions	2,295	2,363	2,363	2,475	2,698	2,965	$15,159
Polyhedron	5,146	5,492	5,849	6,288	6,697	7,049	$ 36,521
Inorganica Chimica Acta	6,302	6,726	7,163	7,701	8,202	8,633	$ 44,727

TABLE 2
Pagination Comparison for Related Titles

	NUMBER OF PAGES						TOTAL
JOURNAL	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	PAGES
Inorganic Chemistry	6,145	7,104	7,170	8,910	8,657	9,977	47,900
Dalton Transactions	4,701	3,671	4,754	4,780	4,208	3,928	26,042
Polyhedron	2,770	3,423	2,885	3,621	3,273	3,118	19,090
Inorganica Chimica Acta	4,148	3,427	4,148	5,064	4,644	4,588	26,019

TABLE 3
Cost-per-Page Comparisons for Related Titles

	COST PER PAGE ($)						
JOURNAL	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	TOTAL ($)
Inorganic Chemistry	0.29	0.27	0.28	0.25	0.28	0.26	0.27
Dalton Transactions	0.49	0.64	0.50	0.52	0.64	0.75	0.58
Polyhedron	1.86	1.60	2.03	1.74	2.05	2.26	1.91
Inorganica Chimica Acta	1.52	1.96	1.73	1.52	1.77	1.88	1.72

Fluctuations in the Foreign Exchange Rate

Following the introduction of floating exchange rates, the U.S. dollar (USD) increased against the Deutsch Mark (DM) from $0.31 at the end of 1972 to $0.41 by mid-1973. This alone led to a one-year 32 percent increase in USD subscription prices without any change in subscription rates. By early

1980, the exchange rate had leveled off at $0.59 DM, and then began to decline until it reached a low of $0.31 DM in March 1985. Although some commercial publishers appeared to take advantage of this situation and explained the need for higher subscription prices on inflation and increased scientific output, the rising value of the USD versus European currencies meant that USD prices remained fairly stable in the early 1980s.[2]

This relatively benign period for U.S. libraries presaged the serials crisis of 1985–88, in which the DM increased to $0.62 in 1988, resulting in skyrocketing USD subscription prices. For example, during this period *Cell and Tissue Research* posted a USD increase of 90 percent from $1,121 to $2,133, while the DM subscription rate increased only 18 percent.[3] Throughout the 1990s, exchange rates remained relatively stable, with the average cost of a DM peaking at $0.63 in 1997. Thereafter, the DM again began to decline against the USD, and U.S. libraries experienced very small (approximately 3 percent) subscription price increases in 1998 and (approximately 2 percent) decreases in 1999.

In 2000, the major European commercial publishers took a radically different approach to subscription pricing. They simply disassociated the USD subscription price from the DM—and subsequently, the euro—and no longer offered subscriptions to North American libraries at the converted euro price, thus guaranteeing annual price increases. Had previous pricing formulas been followed, U.S. libraries would have realized significant annual savings. Table 4 lists the actual USD subscription rates for 2000–2006, compared with the rates based on the pre-2000 pricing policy (in parentheses).

TABLE 4
Actual USD Pricing (USD Pricing under Pre-2000 Policy)

JOURNAL TITLE	2000	2001	2002	2003	2004	2005	2006
*BBA**	11,362	12,127	12,915	13,884	14,786	15,599	16,418
	(10,895)	(9,535)	(10,504)	(11,120)	(13,852)	(16,595)	(18,640)
Brain Research	16,344	17,444	18,578	19,971	21,269	22,386	23,617
	(15,673)	(13,716)	(15,109)	(15,996)	(19,926)	(23,813)	(26,749)

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ISI Impact Factors, Journal Quality, and Cost-Effectiveness

A journal's ISI impact factor is the ratio of a given year's citations to articles published during the previous two years.[4] For example, if X = the

number of 2005 citations to articles published in 2003 and 2004, and Y= the number of articles published in 2003 and 2004, then Z= X/Y is the 2005 impact factor. ISI impact factors are widely accepted as the measure of a journal's quality. Comparisons of ISI impact factors are only valid within specific subjects and content formats. For example, a comparison of impact factors of inorganic chemistry journals is shown in table 5.

While there may be overall concerns about the validity of comparing impact factors, the general trend, as revealed by table 5, confirms the overall quality of *Inorganic Chemistry* (American Chemical Society) and *Dalton Transactions* (Royal Society of Chemistry) compared with *Polyhedron* (Pergamon/Elsevier) and *Inorganica Chimica Acta* (Elsevier). Impact factors are also useful in extending the cost-per-page data to measure cost-effectiveness as may be seen in table 6.[5]

At a minimum, these values indicate that *Inorganic Chemistry* is more cost-effective than its commercial counterparts by a factor of about 14. The data also suggest that for *Polyhedron* and *Inorganica Chimica Acta* to be as cost-effective as *Inorganic Chemistry*, their 2005 subscription prices would have to have been $418 and $492 respectively, rather than $7,049 and $8,633.

TABLE 5
Comparison of ISI Impact Factors for Selected Inorganic Chemisty

JOURNAL TITLE	2000	2001	2002	2003	2004	2005
Inorganic Chemistry	2.7	3.0	3.0	3.4	3.5	3.9
Dalton Transactions	2.5	2.8	3.0	2.9	2.9	3.0
Polyhedron	1.0	1.2	1.4	1.6	1.6	2.0
Inorganica Chimica Acta	1.2	1.4	1.6	1.6	1.6	1.6

TABLE 6
Comparison of Cost-Effectiveness Data for Selected Inorganic Chemistry Journals (Normalized Cost-per-Page/Impact Factor)

JOURNAL TITLE	2000	2001	2002	2003	2004	2005	AVERAGE
Inorganic Chemistry	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Dalton Transactions	1.82	2.54	1.79	2.44	2.76	3.73	2.52
Polyhedron	17.38	14.81	15.59	14.80	16.02	16.87	15.91
Inorganica Chimica Acta	11.83	15.56	11.63	12.93	13.83	17.54	13.89

Three major commercial publishers currently offer deals based on previous print subscriptions (Elsevier's ScienceDirect, Springer-Link, and Wiley's Enhanced Access License). The arrangements differ and seem to be in constant flux and subject to negotiation. While there are some obvious benefits to these types of arrangements (especially if consortia arrangements are offered), either directly or indirectly, they inhibit libraries from carrying out their responsibilities for managing their collections by requiring either multiyear commitments or annual cost increases.

The concept of OA is based on the premise that research funded by public agencies and published in scholarly journals should be freely available.[6] Many scholars believe that OA may offer a solution to the budget problems facing libraries, and some library users and university administrators have even been led to believe that OA journals are available free of charge, making it difficult for libraries to make the case for increased funding.[7] Because OA publishers often receive financial support in the form of grants from foundations, and donations, sponsorships, and memberships from private citizens, universities, and profit or nonprofit organizations, they may compete with traditional journals for money that would in the past have been used to fund traditional subscriptions.

The misconception that access to OA journals is free creates difficulties for librarians, who must convince administrators that increased funding is needed not only to keep pace with serials price increases and but also to allow them to continue the transition from print to electronic collections. Journals offered on so-called OA Web sites are often based on per-article charges or membership fees that are ongoing, unpredictable, and almost always beyond the library's control, rather than based on traditional subscription fees. Because there are no standards of quality for OA journals, it remains to be seen whether they will be successful in the highly competitive world of scientific publishing. Before replacing traditional journals with OA titles, libraries should carefully consider the various OA models, contribution structures, and pricing arrangements offered:

> The OA-journal model requires authors or sponsors to pay a publication fee. Because journal article publication cannot be truly free, an obvious alternative to subscriptions (i.e. reader pays) is the assessment of author charges. Until recently page charges for publication had been a long-standing practice, particularly among society publishers, and this sharing of publication costs between authors and subscribers enabled societies to maintain reasonable subscrip-

tion rates. In the last few years, this practice has been largely abandoned because of intense competition from commercial publishers who do not assess any page charges.[8]

The author-pays model might be viewed as a major threat to commercial publishers because authors and sponsors would obviously favor lower-cost publishers with lower charges, and the competitive impact would be chiefly on commercially published journals that are overpriced by such metrics as cost-per-page/impact factor.

The self-archiving, or repository, model depends on the author to post an electronic version of the article. Often the article is not in its final state, but rather, is a preprint version that is very close to the final version. This model may be seen as a more modern version of the reprint card system that was used to obtain copies of articles before the advent of photocopy machines. As the volume of OA research available on the Web increases, its impact will likely have a disproportionate effect on commercial publishers because very high-priced titles are most likely to be dropped if libraries find that access to self-archived articles is an acceptable substitute for the journal itself. Commercial vendors are beginning to respond to these variant access models by, for example, allowing authors to post the final version of articles on a personal or institutional Web site.[9]

The embargo model seems to be preferred by nonprofit publishers, such as PubMed Central and the Royal Society of Chemistry, because it provides access to publications after varying periods of time. PDF versions of articles published between specific years are accessible, and a year's worth of content is added at the beginning of each new year.[10]

The hybrid model includes a wide variety of print and electronic combinations, incorporating features of the other models. For example, JBC Papers in Press provides access to articles accepted by the *Journal of Biological Chemistry* prior to copyediting and publication. Articles from the previous year become freely available on January 1 of the following year. JBC receives about one-third of its publication costs from page charges to authors ($75 per page, plus charges for tables and figures) and about two-thirds from subscription revenues, primarily from libraries.[11] In addition to providing free access to all nonarticle material, such as editorials, letters to the editor, book and software reviews, the International Union of Crystallography offers access to any current or previously published research

article for a fee of $800.[12] Springer maintains a similar policy that provides a mix of both standard subscriber-only papers with OA papers for authors willing to pay a processing fee of $3,000 in addition to any charges for special processing, such as color or extra length.[13] EDP Sciences, co-publisher, with Springer, of the *European Physical Journal*, also publishes *EPJdirect*; originally both access and submission were free.[14]

Questions of Content, Archiving, and Access

Librarians have a long history of dealing with print journals—a perspective that continues to influence many of their decisions. For example, the libraries of the University of California system and Harvard University, as well as the Center for Research Libraries, are partnering with JSTOR to preserve print copies of all volumes in the JSTOR electronic archive.[15] Preserving print editions at multiple locations will insure long-term preservation of journal content using time-proven techniques. Questions about content are closely linked to matters of archiving. What must be archived? What, if anything, is the copy of record? What is the preferred or authoritative copy? Which version of an article is the one to which a patron should be referred, and to which version should a direct link be made from an online database? Unfortunately, traditional archiving techniques are no longer appropriate; the online versions of many journals contain material, such as extensive data, videos, and other multimedia, that does not exist in the print version. In fact, for an increasing number of journals, there is no such thing as a print version. Librarians must turn their attention to preservation of online content because the print version is rapidly becoming a lingering remnant of the past, like a buggy-whip holder on an early horseless carriage.

As electronic journals become ubiquitous, particularly in the sciences, engineering, and technology fields, the online versions of journals are often considered the versions of record (the versions deemed authoritative in case of a discrepancy). It is possible that there may be several online versions of a publication, so distinguishing among them is very important. Publishers frequently include additional features in the electronic version, such as full-text search capabilities, in an effort to make it the preferred version. Aggregators may provide digitized full-text versions of journals as well; however, these versions often lack internal links and illustrations or other critical components.[16]

Publishers may also limit the content of the online version. For example, the online edition of *Science* initially featured a section titled ScienceExpress, which gave individual members, but not institutional members, of the American Association for the Advancement of Science (AAAS) access to articles prior to publication. As the intricacies of online subscriptions are worked out, it is hoped that publishers will recognize the need to provide mechanisms to give both individual and institutional subscribers access to the entire content of their publications.

It is important to take note of the preprint archives that have become *de facto* primary sources of research articles in some fields. The pioneer in this arena is Paul Ginsparg's arXiv, which is considered the most important source of technical information for researchers in theoretical physics and mathematics.[17] The overwhelming acceptance of electronic preprints in many scientific disciplines means that publishers more readily allow authors to keep preprint versions, and in some cases, published versions of their papers on their personal Web sites after publication. An interesting study found that papers published in *Astrophysical Journal* and also posted on arXiv were cited more than twice as often as papers not posted there.[18] A comparison of citation rates for computer science papers that were freely available online with those not freely available electronically produced a similar finding.[19] While it is not possible to generalize across all disciplines based on these studies alone, the findings appear to make a persuasive case for the benefits of some form of OA.

Preservation of print is not the only task now facing libraries. Depending on the context, *archiving* may mean either the conversion of printed material into an electronic form or the procedures undertaken to ensure the preservation of content that is in electronic form. Converting print resources into electronic form now occurs almost routinely.[20]

Among researchers and librarians alike, one of the greatest causes of apprehension about the migration from a print to an electronic format is the complex matter of guaranteeing the integrity of the content. The scholarly community needs assurances that the complete content of journals will be reliably maintained and accessible in perpetuity. This requires, first of all, that the entire content of print journals be replicated in online versions, which is not always the case and, for security purposes, that the content is maintained at several independent sites and periodically and systematically refreshed. In addition, migration of the data must be possible as new formats and storage media are developed.

These concerns were exacerbated when the discovery was made that in an unknown number of journals, some print content had been excluded from the online versions. The online version of the June 2000 issue of

Mechanism and Machine Theory lacked the obituary of a distinguished engineer. In this instance, the decision to omit the material was made at the discretion of the editor. Due in large part to objections from librarians, a new policy was implemented so that "since approximately October 2001, the electronic capture rule is as follows: **"All items which appear in the table of contents of the physical printed issue will be captured electronically and made retrievable via ScienceDirect. Items which are not in the table of contents will not be available on ScienceDirect"** [bold face in original quote].[21] Incomplete archiving is not unique to commercial publications, and it would be desirable if publishers would commit to cover-to-cover archiving of their publications as is done for the journals archived in JSTOR or for the *Scientific American* Archive Online.

The inexorable decay of magnetic storage media and the anticipated changes in storage software and hardware create additional concerns about the stability of digitized material. Magnetic, optical, and electronic storage media degrade, distorting entire files. The possibility of human intervention to remove articles must also be considered.[22] An article in the *Chronicle of Higher Education* brought the matter to light and resulted in a revision to one publisher's policy on article withdrawal.[23] Under the terms of the new policy, retracted articles are retained in the database with an appropriate warning, unless legal ramifications are anticipated, in which case the text may be removed and a disclaimer added. Policies such as those announced by the American Physical Society are preferable:

> The American Physical Society has taken the position that articles, once put in place on line, should remain there as part of the scholarly record. We cannot, of course, guarantee that the appearance of a plagiarized article in one of our journals might not cause legal action on the part of another publisher to force us to remove the article. We would in that case try to negotiate with them to allow us to keep the article on line with a suitable acknowledgement that the article was plagiarized.[24]

In order to alleviate some of the concerns that have surfaced surrounding archiving and perpetual access, publishers are exploring a number of different strategies. In some instances, individual institutions have been allowed to maintain content on their own servers.[25] However, questions about the governing policies of such archives are still uncertain; for example, would the contributing publishers have authority over such matters as withdrawal of disputed publications? In other instances, publishers maintain their own mirror sites and ensure that in case their principal site should fail, a switchover to an alternate site would seamlessly occur.

The Lots of Copies Keeps Stuff Safe (LOCKSS) project, initiated at Stanford University has taken a different approach to archiving by establishing a *dark* archive where electronic data is stored and can be accessed in the event of a problem with the publishers' servers.[26] Content from more than sixty publishers is maintained on a number of servers that automatically cross-compare content to assure stability. Currently only the documents themselves are loaded on the LOCKSS servers, not the links between documents or to other metadata, so the preservation is not complete, but LOCKSS is widely viewed as a useful starting point in the discussion about archiving.

Another approach to archiving, although it is one that is somewhat problematic, is author self-archiving. Because not all publishers allow this method of archiving and the process is dispersed rather than consolidated, coordinating the universe of publications is more difficult and lacks long-term assurance of accessibility.[27] Instead of a strategy for long-term archiving, perhaps self-archiving would be better viewed as an approach to OA. Unfortunately, a few publishers, notably the American Chemical Society (ACS), do not allow self-archiving or permit local loading of their journals. The society does not participate in LOCKSS, nor does it currently have a mirror site, and this lack of attention to archiving inhibits libraries from converting their ACS subscriptions to online only.

The rise in the availability of electronic journals has had a great impact on interlibrary loan (ILL) services. Standard practices commonly accepted in the print world are not universally recognized by providers of electronic publications; therefore, ILL provisions for electronic journals differ more than provisions for print and vary widely from publisher to publisher. Some publishers may allow electronic transmission of requested articles, while others permit only fax delivery. The most restrictive arrangements only permit copies from an electronic copy to be sent by mail to borrowing libraries.[28] Publishers that allow online purchase of individual articles may not permit ILL to for-profit entities. The interpretation of fair use in the print world is being challenged by some entities in the electronic realm. As a result, it is no longer possible to have a standard ILL process that applies to publishers, vendors, and aggregators. When negotiating license agreements, libraries should attempt to adhere to the fair-use principles recognized by both user communities and publishers in the print environment. While the formats are different, the current electronic environment should not change the concept of fair use.[29] As scientists often need information more quickly than researchers in other disciplines, they often seek other ways to secure articles, rather than deal with ILL procedures that may be hampered by complex license restrictions.

Conclusion

Nowhere have electronic journals been more enthusiastically embraced than in the STM community. Nonetheless, most libraries have experienced problems or been alerted to issues that are unique to an electronic environment. In order to complete the transition from a print to an electronic-only subscription arrangement, libraries need to convince their communities that electronic journals are at least as reliable and convenient as their print counterparts, if not more so. The reliability of electronic journal Web sites or servers and the timely uploading of new issues are important to the science and engineering communities where information must be shared and rapidly dispersed.

Publications in STM have traditionally been on the bleeding edge of serials issues, with the highest average costs, the biggest price increases, and the largest proportion of title changes and other cataloging challenges. Libraries, as early adopters of electronic journals, many with unique content, have learned to adapt to the challenges these resources present. STM publications have continued to present disproportionately large management challenges in the electronic milieu, including large numbers of publisher, URL, and aggregator changes, and the potential interruption in access resulting from these changes can be particularly disruptive in the rapidly moving STM fields. Because STM libraries adopted electronic journals (many with unique content) early on, they have learned to adapt to the challenges these resources present.

Although the management of electronic journals presents new problems, it also allows libraries to give up some traditional tasks, such as claiming undelivered issues, replacing defective issues, or grappling with incomplete volumes prior to binding. Many publishers have shown a willingness to learn from their customers; for example, by providing IP-based, site-wide access instead of the password-protected access that some publishers initially offered. Librarians are hopeful that publishers will continue to implement procedures that are beneficial to the scholarly community, and will work with, rather than in opposition to such scholars' initiatives as arXiv and the Public Library of Science, and adopt the best features of these experiments. As publishers, jobbers, aggregators, and libraries adapt to the electronic environment, it will be easier and less expensive for librarians to provide users with immediate access to important information.

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16. For example, Wilson Select lacks links in the references for the Annual Review series.
17. arXiv, http://arxiv.org (accessed 14 August 2006). Preprints in the field of high-energy physics are also indexed by SPIRES at www.slac.stanford.edu/spires/hep/; computer science preprints are indexed at several servers, including Networked Computer Science Technical Reference Library at www.ncstrl.org/; mathematics preprint servers may be found at the Directory of Mathematics Preprint and E-print Servers at http://e-math.ams.org/global-preprints/; cognitive science and neuroscience has a site for self-archived preprints at Cogprints: Cognitive Sciences E-print Archive at http://cogprints.org/; E-print Network is a government Web site integrating scientific and technical e-prints from a wide range of sources at www.osti.gov/eprints/; another preprint metasite is Service Provider Web Site SAIL-eprints at http://eprints.bo.cnr.it/. Some libraries try to maintain listings of preprint servers, such as the University of Virginia Charles L. Brown Science and Engineering Library's Preprint Servers and Databases Web page at www.lib.virginia.edu/science/guides/s-preprn.htm and the John Crerar Library's Science Preprint and Open Access Servers Web page at www.lib.uchicago.edu/e/su/sci/preprints.html, but keeping the information up-to-date is very difficult. In general, successful preprint servers are associated with scholarly societies, universities, or other nonprofit entities; an attempt by Elsevier to create preprint servers in mathematics, chemistry, and computer science did not generate contributions "in sufficient numbers to justify further development" and new submissions were terminated on 24 May 2004. See the ScienceDirect Preprint Archive at www.sciencedirect.com/preprintarchive (accessed 15 August 2006). Some other servers that harvest Open Archives Initiative (OAI)–compatible preprint and other full-text sources are listed in Gerry McKiernan, "OAI Service Providers," *Science & Technology Libraries* 23, no. 1 (2002): 87–98, www.public.iastate.edu/~gerrymck/OAISP.pdf (accessed 15 August 2006).
18. Greg J. Schwarz and Robert C. Kennicutt, Jr., "Demographic and Citation Trends in Astrophysical Journal Papers and Preprints," Cornell University Library arXiv.org, 10 November 2004, http://arxiv.org/PS_cache/astro-ph/pdf/0411/0411275.pdf (accessed 14 August 2006).
19. Steve Lawrence, "Online or Invisible?" Ivyspring International Publisher site, http://ivyspring.com/steveLawrence/SteveLawrence.htm (accessed 15 August 2006). Edited version appears as "Free Online Availability Substantially Increases a Paper's Impact," *Nature* 411, no. 6837 (31 May 2001): 521.
20. There are several examples, of which one of the earliest and most comprehensive is JSTOR (www.jstor.org), a subscription-based archive that was established through a grant from the Andrew W. Mellon Foundation. In addition to JSTOR, there are also

numerous efforts to create online archives of content for publications that had existed only in print such as the Bibliothèque nationale de France's Gallica (http://gallica.bnf.fr/periodiques.htm), the Numérisation de Documents Anciens Mathématiques/ Digitization of Ancient Mathematics Documents (www.numdam.org/en/); the Electronic Mathematical Archiving Network Initiative (www.emani.org/); the Japan Science and Technology Information Aggregator, Electronic (www.jstage.jst.go.jp/browse/_journallist/-char/en); the Cornell University Albert R. Mann Library's Core Historical Literature of Agriculture (http://chla.mannlib.cornell.edu/c/chla/browse/journals.html); to create online archives of content that had existed only in print; and some individual journals, such as the *American Journal of Science*, available www.geology.yale.edu/~ajs/Regular.html. Apart from JSTOR, all of these provide free access worldwide. A number of scientific societies, including the American Physical Society, American Physiological Society, the Institute of Physics, the American Chemical Society, the Royal Society of Chemistry, and the Society for Industrial and Applied Mathematics have digitized their publications and commercial publishers are doing the same. Some societies, such as the Korean Chemical Society (http://journal.kcsnet.or.kr/) have made their content available on the Web for free. Others provide free content up to a "moving wall;" for example, the *Proceedings of the National Academy of Sciences* (http://pnas.org) is available from volume 1 (1915) up to six months prior to the present date. (All accessed 15 August 2006.)

21. ScienceDirect Info, "Frequently Asked Questions," www.info.sciencedirect.com/implementing/faq/ (accessed 15 August 2006). This is certainly an enormous improvement, and it is gratifying when a major publisher heeds customers, although a response (April 2005) by Elsevier to a complaint about missing content elicited the following comment: "currently have around 0.5% of missing content on ScienceDirect which is a significant reduction on the figures two years ago." However, there are still difficulties with the online content from both commercial and other publishers, and Elsevier has not indicated that it plans to rectify past omissions (the obituary, for example, is still not included in the online *Mechanism and Machine Theory*); the rule applies only to journals "published as part of Elsevier's core primary publishing program" and may not apply to journals in Elsevier affiliates, such as Cell Press. Some material, such as advertising, is seldom found in tables of contents, and thus will seldom be available online despite its value to researchers and historians.
22. The discussion concerned Elsevier policies that led to the expunging of more than thirty articles from ScienceDirect; they were withdrawn for various reasons, but in each instance the only information available on ScienceDirect was the notice "for legal reasons this article has been removed by the publisher."
23. Andrea Foster, *Chronicle of Higher Education* 49, no. 18 (10 January 2003): A27. For information on the Elsevier policy, see "Elsevier Policy on Article Withdrawal," www.info.sciencedirect.com/licensing/policies/withdrawal (accessed 15 August 2006).
24. Statement by Martin Blume, editor-in-chief of the American Physical Society, may be found at http://listserv.nd.edu/cgi-bin/wa?A2=ind0301&L=pamnet&P=R640 (accessed 15 August 2006).
25. Elsevier publications are *de facto* archived at OhioLINK, the University of Toronto Library, the British Library, Los Alamos National Laboratory, and other repositories, and they have a formal archiving agreement with Koninklijke Bibliotheek (Netherlands).

26. LOCKSS (http://lockss.stanford.edu/). A related preservation program, CLOCKSS (www.lockss.org/clockss/Home) has recently been launched to address global issues "in the event of a long-term business operation, or in making orphaned or abandoned works readily available to the scholarly community." (All accessed 14 August 2006.)
27. While the American Physical Society, American Institute of Physics, Royal Society of Chemistry, and recently, Elsevier, do currently allow self-archiving, the American Chemical Society does not. A very useful list of publishers' policies on self-archiving may be found at SHERPA, www.sherpa.ac.uk/romeo.php (accessed 14 August 2006).
28. Although *borrowing* libraries traditionally report statistics to the Copyright Clearance Center, some publishers require *lending* libraries to provide usage reports, putting an even greater burden on lending libraries.
29. American Society for Engineering Education Engineering Libraries Division, "Biennial Punch List of Best Practices for Electronic Resources," revised May 2005, http://eld.lib.ucdavis.edu/punchlist/PunchlistRevision2005.pdf (accessed 15 August 2006).

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